The Cost of Growing Timber

BY

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AND

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1911.
AMERICAN LUMBERMAN.
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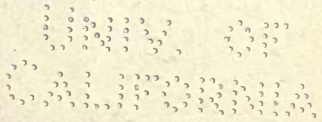

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FOREWORD.

At the seventh annual meeting of the National Lumber Manufacturers' Association in Seattle, Washington, July 12-14, 1909, we presented a paper entitled "How Much Does It Cost to Grow Timber?" The discussion occasioned by this paper and subsequent further study of the subject have led us to revise the original manuscript and publish it in the present form in the belief that the principles set forth are sound and will help toward a clearer conception of the conditions which must be established in the United States if forest conservation is to be a reality. This statement is made with a full realization of the difficulty in forecasting yields and stumpage prices and with the certain knowledge that many, perhaps all, of the assumptions necessary to the exposition will be keenly criticized by someone—forester or lumberman. Nevertheless, it is only through such discussions as these that clear thinking upon a highly important question can be attained, and it is in this spirit that the following pages are offered to the reader by

THE AUTHORS.

THE COST OF GROWING TIMBER.

INTRODUCTION.

Four-fifths of the timber standing in the United States today is privately owned. Only one-fifth of it is now in State and National Forests, and it is not likely that for many years to come even as much as half of the total stumpage of the country will be in public forests. In the future, as in the past, we must depend on private forests for much of our wood supply, and the manner in which private forests is handled is therefore of great economic importance.

Practically all of the lumber so far used in the United States has come from natural, matured forests. Capital has found a profit, and sometimes a great profit, in buying up virgin timber in advance of the demand and holding it until it could be either manufactured or sold to manufacturers at a heavy increase in price over that paid at the time of purchase; that is, much of the profit made in the lumber industry so far has been a speculative profit. The exhaustion of the supply of virgin timber will lessen the chances for speculation and more closely restrict profits to those which arise from growing and manufacturing timber.

The so-called "cost of production" now calculated by manufacturers is merely a harvesting cost, not a cost which includes the expense of growing the timber as well as that of logging and manufacturing it. The growing of timber is analogous to the growing of wheat or corn, except that in the latter case the crop is sown, grown, harvested, and marketed within a year, while in the former case the same series of operations may require from 50 to 100 years. The elements of cost are the same in both. Capital will seek investment in raising neither wheat nor timber unless there is a reasonable chance for profit. We have abundant data upon the cost of producing the great agricultural staples, but few data upon the cost of growing timber.

A permanent timber supply will not be maintained by private effort at less than the cost of production. With sufficient knowledge of the cost of land and stocking, growth and yield, we can estimate what the cost of growing any kind of timber will be and compare it with the present stumpage price. This comparison will show whether the stumpage price may be expected to go up or down in the future and will indicate the minimum amount we may have to pay for timber. Of course, we have no assurance that timber will eventually sell at the bare cost of production, for, if a great shortage results because of our general imprudence in failing to grow timber, or because of unexpectedly heavy demands for it, the selling price will go far above the cost of production. On the other hand, if a certain species grows slowly and yields lightly, or if the soil which it requires be too expensive, so that the cost becomes abnormally high, it may be superseded by timber of other kinds, which may be grown more cheaply. In this case, the price would never equal the cost of production.

It is the purpose of this paper to present a method of analysis of the

elements of cost in growing timber. The assumptions made are thought to be fair and to approximate the usual conditions under which the various species must be grown. With a right method of computation established, those who have need to do so can supply the necessary factors and determine the cost of production for particular cases. With these considerations in mind, the following discussion is given:

ELEMENTS OF COST.

There are five main elements of cost in the growing of timber. They are: (1) The value of the land; (2) the stocking of it with young trees; (3) the administration of the operation and the protection of the growing timber; (4) the taxes; (5) the rate of interest.

The profit or loss at the end of a given period will be determined by the relation between the combined amounts of these investments at the proper rate of interest and the value of the stumpage of the resulting stand of timber at prices then obtainable; or, the total amount of the investments at compound interest, divided by the total yield, will give the absolute cost of production per unit of yield.

In Tables 1 to 6 are brought together the best figures and available estimates upon six important species—white pine, loblolly pine, longleaf pine, red oak, yellow poplar and Douglas fir. The following basic assumptions are made:

LAND VALUE AND STOCKING.

The land as such, regardless of what forest growth there may be on it, and assumed to be unfit for ordinary agricultural crops, is valued uniformly at $3 per acre.

Assuming that the land must be fully planted with young trees, a charge of $7 per acre is allowed. The results obtained by the State of New York and other extensive planters indicate that this amount should be sufficient in planting operations of considerable magnitude. Of course, if cut-over land is restocking naturally with young trees, it is worth more than bare land, but the increased cost of the land should be approximately equal to the amount that would have to be spent for planting. Planting should be unnecessary in many cases, since it is often possible to obtain natural reproduction at low cost, if proper cutting methods are used. Whether we assume a value of $3 per acre for bare land and a cost of planting of $7 yer acre, or allow $10 per acre for land naturally stocked with young trees, the initial investment remains the same. For these reasons the cost of land and stocking are summarized together in the tables.

Many will probably think that the charges for land value and stocking are placed too low, and this is probably true in certain instances. It is deemed better, however, to calculate the cost of growing timber with the lowest possible original investment, than to run into figures which, while entirely true for some conditions, will yet seem preposterous to the uninformed. There is also some merit in placing the fixed charges for all species at the same amount. This brings out more clearly the differences in final costs due to growth and yield.

ADMINISTRATION AND PROTECTION.

The cost of administration and protection will vary greatly with local conditions and the size of the operation. In these calculations, they are

combined and conservatively estimated at 5 cents per acre annually. Protection means chiefly the keeping out of fire, and on large tracts, the necessary labor force can be so managed as to make the amount of this item comparatively small.

Lumbermen maintain, and often justly so, that at present conditions are too hazardous to warrant the long time investment required to produce timber. It is assumed in this paper that the forest owner has the benefit of more efficient State and local measures for fire prevention than now prevail. Until he has, he is not likely to look favorably on timber growing on a large scale as a legitimate commercial enterprise. The risk from fire, wind and insects cannot be closely predicted any more than can the future price of lumber. We know that eventually fires will be controlled, though occasionally forests will be destroyed, even with the best system. On the whole, damages from wind and insects are light and local and do not lead to such heavy losses as does fire.

There is now no insurance for standing timber in this country, nor will there be until our forests are somewhere near as safe as the German forests. Until conditions become such as to make either commercial or mutual insurance feasible, there remains an element of hazard in timber investments, allowance for which will be made by each investor as seems to him best. Where reasonable protection is not furnished, permanent forest investment is impossible.

TAXES.

Two methods of taxing timber are shown: Case 1, the method now in general use, and Case 2, a proposed tax upon the yield only, to be paid when the timber is cut.

Case 1.

Taxes as now levied are extremely variable, but they average about 1 per cent of the actual value of the property. Since assessors pay little attention to young growth before it reaches merchantable size, the taxes are assumed to be equivalent to 10 cents per acre per year (or 1 per cent of the initial cost of land and stocking) up to the date when it is possible to make the first cut. Thereafter they are placed at 1 per cent of the actual stumpage value of the timber plus the original land value ($3 per acre), with reassessments at the periods for which yields are given. With the exception of loblolly pine, this is every ten years.

Case 2.

If a given investment nets 4 per cent, an annual tax of 1 per cent (one-fourth of the annual income) is equivalent to a final tax of one-fourth, or 25 per cent of the yield. Since we do not know what stumpage values will be when the timber is cut, the calculation of the tax on yield is made by simply reducing the yield by the same percentage as the percentage of tax, and then figuring the cost of producing this reduced yield without taxes; that is, if 25 per cent of the selling price of the stumpage goes to the public in lieu of annual taxes, the cost of growing the timber is the same as if 75 per cent of the given yield had been obtained with no tax at all.

With the interest rate at 5 per cent, the final tax must be 20 per cent to yield a return equivalent to a 1 per cent annual tax, and similarly, with

interest at 6 per cent, the final tax becomes 16⅔ per cent. If timberland were valued and taxed annually according to the income it produced, the two methods would yield exactly the same amount of tax.

As a matter of fact, the present method of taxing is not applied in the scientific manner outlined in Case 1, so that the two methods would give still more widely divergent results in practice than those indicated in the subsequent tables. The tax on yield (Case 2) is higher than the common tax for the shorter periods (except for small yields and low stumpage prices) and lower in the longer periods. Since the tax on yield is graduated according to production, it takes the same proportion of the income at all periods, while the general property tax takes an increasing proportion, and must sooner or later force cutting. In other words, the present system of taxation tends to undertax young growth and overtax larger timber.

The tax on yield falls at a time when the owner of the timber is best able to pay; hence, unlike the general property tax, it has no tendency to make him cut when the market is overstocked or before the timber has reached the most profitable cutting stage.

RATE OF INTEREST.

Rates of interest depend largely on the degree of confidence in the investment, or the risk involved, and also upon the ease with which the money invested can be recovered. Thus, government bonds net about 2 or 3 per cent; well-secured bonds of established corporations, 4 or 5 per cent; real estate mortgages, from 4 to 6 per cent; industrial stocks, from 5 to 7 per cent. Farm rents in older communities are regarded as satisfactory by local capital if they give a net income of 4 or 5 per cent.

Forest land is usually the poorest land in the region. Often it could be used for no other purpose. A forest investment is a long time one. With proper protection it is safe and requires little attention upon the part of the investor during the time that it runs. Four per cent is satisfactory in a wide variety of investments which are attended by small risk and extend over a long time. For these reasons 4 per cent has been chosen as conservative in forest calculations. The effect of higher rates of interest is also discussed in connection with the tables.

THE YIELD.

For white pine, loblolly pine, and yellow poplar the yields are based on tables compiled from actual stands on good forest soil of various ages and fully stocked, such as should result from planting. For longleaf pine, red oak, and Douglas fir the yields are based on extensive growth studies and on estimates of the number of trees per acre, calculated on a knowledge of their requirements and carefully checked with other species of similar requirements, whose normal stand per acre is known. The figures assumed for both of the above groups are supported by data on growth and yield published in the report of the National Conservation Commission. The average size of the timber is given in diameter at breast height, the standard point of measurement. The yield is stated in thousands of board feet of square-edged lumber. Thinnings which will be necessary from time to time should pay their cost and in some cases give net returns which are not included in the tables. The common practice in New England is to cut round-edged lumber from second-growth white pine for the box factories.

If it is desired to calculate such material, the yields given in the tables should be increased about 20 per cent.

Lumbermen may object that the yields are too high, since the finest stands of virgin forest do not yield so much. The comparison of a natural untended forest with a planted or tended one is parallel with that of a "volunteer" crop of wheat wholly untended with one carefully drilled in on well-plowed ground. The cultivated crop can always be expected to give the larger yield.

PRESENT STUMPAGE PRICES.

The present stumpage prices quoted are only approximations, since a number of factors, such as ease of logging, stand per acre, distance from market, etc., cause wide variations. Stumpage prices actually obtained vary according to age only in a rough way as the timber appears to the buyer large, medium or small. Most of the timber on the market now is either very old virgin stuff or young so-called "sap timber." For consistent calculations, however, it is necessary to assume stumpage values in the tables and grade them according to age. For this purpose they are deemed fair.

WHITE PINE.

Assuming the factors mentioned, the outlook for white pine under the conditions specified in Table 1 is very good. Case 1 shows a stumpage cost of $2.96 per thousand feet at 40 years and a stumpage price of $5. The stumpage cost is below the present stumpage price to between 70 and 80 years. At 80 years the cost is $9.61 per thousand, with an estimated stumpage price of $9 per thousand. At 90 years the cost is $3.95 per thousand more than the estimated selling price. From 90 years on the cost and selling price would rapidly diverge as the effect of compound interest became greater.

Case 2, in which there is a tax on the yield only, shows a much more favorable condition for investors in the older age classes. Up to nearly 50 years this method makes the cost slightly greater than under Case 1, but still much under the selling price. For older timber the tax on yield alone gives a reduced cost as compared with the ordinary method. At 90 years the difference is $4.74 per thousand in favor of the tax on yield.

Placing the original cost of land and stocking at $15 per acre instead of $10 gives reproduction costs under Case 1 of $4.15, $4.68 and $6.18 per thousand feet at 40, 50 and 60 years, respectively—all well below the stumpage prices.

Table 1.—*White Pine in New England.*

CASE 1.

Land and stocking, $10 per acre; administration and protection, 5 cents per acre; taxes, 10 cents per acre, up to 40 years; thereafter, 1 per cent actual value, with reassessment every 10 years; interest, 4 per cent.

Age Yrs.	*Land and stocking.*	*Adminstration and protection.*	*Taxes.*	*Total cost.*	*Size, in.*	*Yield M. ft.*	*Cost per M.*	*Present stumpage price per M.*
40	$ 45.01	$ 4.75	$ 9.50	$ 59.26	6.7	20	$ 2.96	$ 5.00
50	68.07	7.63	26.43	102.13	9.0	30	3.40	6.00
60	102.20	11.90	61.09	175.19	10.7	38	4.61	7.00
70	152.72	18.21	122.71	293.64	12.0	45	6.53	8.00
80	227.50	27.56	225.19	480.25	12.9	50	9.61	9.00
90	338.19	41.40	387.67	767.26	14.5	55	13.95	10.00

CASE 2.

No annual tax on land or timber; final tax, 25 per cent of yield. Other factors as in Case 1.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.**	*Size, in.*	*Net yield.† M. ft.*	*Cost per M.*	*Present stumpage price per M.*
40	$ 45.01	$ 4.75	One	$ 49.76	6.7	15.0	$3.32	$ 5.00
50	68.07	7.63	quar-	75.70	9.0	22.5	3.36	6.00
60	102.20	11.90	ter	114.10	10.7	28.5	4.00	7.00
70	152.72	18.21	of	170.93	12.0	33.7	5.07	8.00
80	227.50	27.56	yield	250.06	12.9	37.5	6.80	9.00
90	338.19	41.40		379.59	14.5	41.2	9.21	10.00

* Excluding taxes.

† Three-fourths of total yield, one-fourth deducted in lieu of taxes.

The cost of production mounts rapidly with higher rates of interest. At 5 per cent, in Case 1, with the other factors unchanged, the taxes in 50 years amount to $32.63, administration and protection to $10.47, land and stocking to $111.67, a total of $154.77, or $5.16 per thousand, an increase of $1.76 per thousand over the cost at 4 per cent. At 60 years at 5 per cent, the taxes come to $76.17, administration and protection $17.68, land and stocking $183.79, a total of $277.64, or $7.31 per thousand, $2.70 per thousand more than at 4 per cent. If a stumpage price of $7 per thousand for 60-year-old timber is obtained, it will give practically 5 per cent on the investment under the conditions above specified.

With interest at 5 per cent, and the only tax one of 20 per cent of the yield, the stumpage cost in 50 years will be $5.09 per thousand, and in 60 years, $6.63 per thousand. Using 6 per cent interest in the calculation gives for Case 1 a cost of $7.90 per thousand at 50 years, and of $11.89 per thousand at 60 years. Taxing the yield 16⅔ per cent, with 6 per cent interest, we get a cost of $7.83 per thousand at 50 years, and of $11.19 at 60 years. With the older-age classes, the increase in cost by using 6 per cent is even more marked.

The growing of white pine in New England at present stumpage prices should be profitable. On a 50-year rotation under the conditions specified in Case 1, there is $2.60 per thousand profit above 4 per cent interest on the investment. At 60 years, the net profit above 4 per cent is $2.39 per thousand, and at 70 years, $1.47 per thousand feet. Judged from the economic standpoint alone, white pine stumpage prices have gone high enough. They leave a safe margin above the actual cost of production to encourage the investor.

LOBLOLLY PINE.

The method of estimating the cost for loblolly pine (Table 2) is identical with that for white pine, except that a reassessment is assumed every 5 years to correspond with the yields, which are for 5-year periods. Owing to the very rapid growth of loblolly, or old-field pine, in the coastal region of the Carolinas, Virginia, and Maryland, the first yields can be obtained in 25 years under favorable conditions. The figures indicate a cut of 12,000 feet at that age from fully stocked stands. This is of timber averaging nearly 8 inches in diameter, which is suitable for boxes and crates. At 40 years the estimated yield is 19,000 feet per acre of timber averaging 10.6 inches in diameter, which will make small lumber or railroad ties. The estimated cost is $3.42 per thousand under Case 1, and $3.48 under

Case 2. At 50 years, the yield is 23,000 feet of 12-inch timber, which means a range of from 8 inches to 18 inches. The data at hand do not furnish sufficient basis for detailed estimates beyond 50 years. For larger material, say 70 years old, the cost would rise to about $8 per thousand.

Table 2.—*Loblolly Pine in the Carolinas and Virginia.*

CASE 1.

Land and stocking, $10 per acre; administration and protection, 5 cents per acre; taxes 10 cents per acre, up to 25 years; thereafter, 1 percent actual value, with reassessment every 5 years; interest, 4 per cent.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.*	*Size, in.*	*Yield M. ft.*	*Cost per M.*	*Present stumpage price per M.*
25	$ 23.66	$ 2.08	$ 4.16	$ 29.90	7.8	12	$ 2.49	$ 2.00
30	29.43	2.80	6.52	38.75	8.9	15	2.58	2.50
35	36.46	3.68	10.12	50.26	9.8	17	2.96	3.00
40	45.01	4.75	15.24	65.00	10.6	19	3.42	3.50
45	55.41	6.05	22.31	83.77	11.4	21	3.99	4.00
50	68.07	7.63	31.86	107.56	12.2	23	4.68	4.50

CASE 2.

No annual tax on land or timber; final tax, 25 percent of yield. Other factors as in Case 1.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.**	*Size, in.*	*Net yield† M. ft.*	*Cost per M.*	*Present stumpage price per M.*
25	$ 23.66	$ 2.08	One	$ 25.74	7.8	9.0	$ 2.86	$ 2.00
30	29.43	2.80	quar-	32.23	8.9	11.2	2.88	2.50
35	36.46	3.68	ter of	40.14	9.8	12.7	3.16	3.00
40	45.01	4.75	yield	49.76	10.6	14.3	3.48	3.50
45	55.41	6.05		61.46	11.4	15.7	3.90	4.00
50	68.07	7.63		75.70	12.2	17.2	4.40	4.50

* Excluding taxes.
† Three-fourths of total yield, one-fourth deducted in lieu of taxes.

Since much of the loblolly pine grows upon soil that has considerable agricultural value, the effect of higher priced land must be taken into account. Allowing $15 per acre for land and stocking, under Case 1, the cost at 40 years is $4.67 per thousand, and at $20 per acre it is $5.92 per thousand, which is very reasonable.

With either method of taxation, the cost of producing loblolly pine is low, and in most cases less than the present stumpage prices. It will evidently pay to grow loblolly pine timber under such conditions as above specified.

LONGLEAF PINE.

Longleaf pine is a slow-growing species, and it requires almost 90 years to reach a size attained by loblolly pine in 50 years, or by white pine in 80 years. Moreover, the trees will not grow in as dense stands as white pine. This lessens the yield. It is assumed in Table 3 that the first cutting stage will be reached in 70 years, when the timber should average about 10 inches in diameter and give a yield of 17,000 feet per acre, the same yield as for loblolly pine at 35 years. In longleaf pine the first cutting diameter is set higher than in loblolly or white pine, because longleaf is not so suitable for box boards and other small-sized material. It will be noted how tremendously the cost of growing increases with age, due to the effect of compound interest and comparatively small yields. At 70 years under the common method of taxation, the estimated cost is $12.20 per thousand. At

100 years, with timber averaging only a little more than 14 inches in diameter, which means a range of from 10 inches to 20 inches, the cost is $22.28 per thousand; and at 120 years, with timber averaging 16.4 inches in diameter the cost is $42.23 per thousand. While taxes pile up heavily, they are far from being the most important item in the investment. Most of the cost is due to the interest upon the land and growing stock. At 70 years this amounts to more than four times as much as the taxes, and at 120 years it is over three times as much. The cost for administration and protection ranges from $1.07 per thousand at 70 years to $3.61 per thousand at 120 years.

With the only tax one of 25 percent of the yield, the cost is slightly greater throughout than under Case 1. This is because the stumpage price is low and the yield small. With higher stumpage prices and yields, the tax on yield is more favorable to the owner than is the general property tax.

Table 3.—*Longleaf Pine in the South.*

CASE 1.

Land and stocking, $10 per acre; adminsitration and protection, 5 cents per acre; taxes, 10 cents per acre up to 70 years, thereafter 1 percent actual value, with reassessment every ten years; interest, 4 percent.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.*	*Size, in.*	*Yield M. ft.*	*Cost per M.*	*Present stumpage price per M.*
70	$ 152.72	$ 18.21	$ 36.43	$ 207.36	9.9	17	$12.20	$ 2.00
80	227.50	27.56	58.36	313.42	11.4	23	13.63	2.50
90	338.19	41.40	93.64	473.23	12.9	28	16.90	3.00
100	502.05	61.88	149.03	712.96	14.2	32	22.28	3.50
110	744.60	92.20	234.37	1,071.17	15.3	35	30.60	4.00
120	1,103.63	137.08	364.04	1,604.75	16.4	38	42.23	4.50

CASE 2.

No annual tax on land or timber; final tax, 25 percent of yield. Other factors as in Case 1.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.**	*Size, in.*	*Net yield† M. ft.*	*Cost per M.*	*Present stumpage price per M.*
70	$ 152.72	$ 18.21	One	$ 170.93	9.9	12.7	$13.46	$ 2.00
80	227.50	27.56	quar-	255.06	11.4	17.2	14.83	2.50
90	338.19	41.40	ter	379.59	12.9	21.0	18.08	3.00
100	502.05	61.88	of	563.93	14.2	24.0	23.50	3.50
110	744.60	92.20	yield	836.80	15.3	26.3	31.82	4.00
120	1,103.63	137.08		1,240.71	16.4	28.5	43.53	4.50

* Excluding taxes.

† Three-fourths of total yield, one-fourth deducted in lieu of taxes.

The conclusion to be drawn from the longleaf pine table is that, under the conditions specified, it can not be grown profitably. The stumpage costs are higher than it is likely that stumpage prices will go. It may be that 100 years hence longleaf pine stumpage averaging 14 inches in diameter will sell for $22 per thousand, but the chance that it will do so is not great enough to lead capital to purchase bare land and plant it to longleaf pine trees.

If we are to have longleaf pine permanently we must evidently favor it. Since the greatest element of cost is the land and stocking, this item should be decreased if possible. If the investor can get longleaf pine land with sufficient young growth upon it eventually to produce a full merchant-

able crop for $5 per acre, instead of $10, as given in the table, he will have a stumpage cost of $6.55 per thousand at 70 years, with the present method of taxing, and of $7.33 per thousand, with the only tax one of 25 percent of the yield. With land and stocking at $5 per acre, the stumpage cost at 100 years becomes $12.54 per thousand in the first case, and $13.98 in the second. Thus, while the growing of longleaf pine is not an attractive investment to the man who must pay from $5 to $10 per acre to start with, the outlook becomes more favorable for the owners of large areas on which natural reproduction can be secured at low cost by leaving a few seed trees and keeping out fires. Under such conditions there is an opportunity for the profitable growing of longleaf pine.

RED OAK.

The first cut for red oak is set at 40 years, with timber averaging 10.3 inches in diameter, which should give a range of from 6 inches to 16 inches and a yield of 11,000 board feet. The estimated cost (shown in Table 4) is $5.39 per thousand for Case 1, and $6.07 per thousand for Case 2. While in both cases the cost of production runs above the present stumpage prices, it is not excessive until 80 years, when it is $14.02 per thousand for Case 1, and $13.64 for Case 2, with a yield of 25,000 feet of timber averaging 16.7 inches in diameter. At 90 years, with a tax on yield only, the cost is $18.70 per thousand for timber averaging 18 inches in diameter, which will give many trees running up to 24 inches or more. With the increase which may be expected in stumpage prices, the chance for profitably growing red oak of the smaller sizes is evidently very good.

Table 4.—*Red Oak in the Southern Hardwood Region.*

CASE 1.

Land and stocking, $10 per acre; administration and protection, 5 cents per acre; taxes, 10 cents per acre up to 40 years, thereafter 1 percent actual value, with reassessment every 10 years; interest, 4 percent.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.*	*Size, in.*	*Yield M. ft.*	*Cost per M.*	*Present stumpage price per M.*
40	$ 45.01	$ 4.75	$ 9.50	$ 59.26	10.3	11	$ 5.39	$ 2.00
50	68.07	7.63	17.06	92.76	12.4	15	6.18	3.00
60	102.20	11.90	31.01	145.11	14.1	19	7.64	4.00
70	152.72	18.21	55.37	226.30	15.4	22	10.29	5.00
80	227.50	27.56	95.52	350.58	16.7	25	14.02	6.00
90	338.19	41.40	159.74	539.33	18.0	27	19.98	7.00
100	502.05	61.88	259.47	823.40	19.0	29	28.39	8.00

CASE 2.

No annual tax on land or timber; final tax, 25 percent of yield. Other factors as in Case 1.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.**	*Size, in.*	*Net yield† M. ft.*	*Cost per M.*	*Present stumpage price per M.*
40	$ 45.01	$ 4.75	One-	$ 49.76	10.3	8.2	$ 6.07	$2.00
50	68.07	7.63	quar-	75.70	12.4	11.2	6.76	3.00
60	102.20	11.90	ter	114.10	14.1	14.3	7.98	4.00
70	152.72	18.21	of	170.93	15.4	16.5	10.36	5.00
80	227.50	27.56	yield	255.06	16.7	18.7	13.64	6.00
90	338.19	41.40		379.59	18.0	20.3	18.70	7.00
100	502.05	61.88		563.93	19.0	21.8	25.87	8.00

* Excluding taxes.

† Three-fourths of total yield, one-fourth deducted in lieu of taxes.

YELLOW POPLAR.

The prospects for yellow poplar, shown in Table 5, are somewhat better than for red oak. It grows a little more rapidly, gives a little greater yield, and has a correspondingly lower reproduction cost. At 50 years there is an estimated yield of 18,000 feet of timber averaging 12.8 inches in diameter, costing $5.17 per thousand under Case 1, and $5.61 under Case 2. Yellow poplar is such a highly useful wood that it will always be needed by our varied industries. We can evidently obtain the smaller sizes at a cost which is not excessive. If we want big trees we must pay a high price for them.

Table 5.—*Yellow poplar in the southern hardwood region.*

CASE 1.

Land and stocking, $10 per acre; administration and protection, 5 cents per acre; taxes, 10 cents per acre up to 40 years; thereafter 1 percent actual value, with reassessment every 10 years; interest, 4 percent.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.*	*Size, in.*	*Yield M. ft.*	*Cost per M.*	*Present stumpage price per M.*
40	$ 45.01	$ 4.75	$9.50	$ 59.26	10.5	12	$ 4.94	$2.00
50	68.07	7.63	17.30	93.00	12.8	18	5.17	3.00
60	102.20	11.90	32.44	146.54	14.7	23	6.37	4.00
70	152.72	18.21	59.42	230.35	16.1	25	9.21	5.00
80	227.50	27.56	103.31	358.37	17.3	27	13.27	6.00
90	338.19	41.40	172.71	552.30	18.5	29	19.04	7.00
100	502.05	61.88	280.34	844.27	19.5	31	27.23	8.00

CASE 2.

No annual tax on land or timber; final tax, 25 percent of yield. Other factors as in Case 1.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.**	*Size, in.*	*Net yield† M. ft.*	*Cost per M.*	*Present stumpage price per M.*
40	$ 45.01	$ 4.75	One-	$ 49.76	10.5	9.0	$ 5.53	$2.00
50	68.07	7.63	quar-	75.70	12.8	13.5	5.61	3.00
60	102.20	11.90	ter	114.10	14.7	17.2	6.63	4.00
70	152.72	18.21	of	170.93	16.1	18.7	9.14	5.00
80	227.50	27.56	yield.	255.06	17.3	20.3	12.56	6.00
90	338.19	41.40		379.59	18.5	21.8	17.41	7.00
100	502.05	61.88		563.93	19.5	23.2	24.31	8.00

* Excluding taxes.
† Three-fourths of total yield, one-fourth deducted in lieu of taxes.

DOUGLAS FIR.

From every viewpoint, Douglas fir is one of the most interesting species. There is more of it now standing than of any other timber in the United States. It grows rapidly in extremely heavy stands, and can be protected cheaply.

Table 6 gives estimates of the cost of growing Douglas fir in the region of its best development; that is, in western Washington and Oregon. The first cut is placed at 40 years, with an average diameter of 10.6 inches, and a yield of 24,000 feet per acre. This makes the cost of production $2.47 per thousand in Case 1, and $2.76 in Case 2. At 70 years, with timber averaging 18.4 inches in diameter and ranging from 14 inches to 28 inches, the yield is 50,000 feet per acre, making the cost $4.50 per thousand in Case 1, and $4.56 in Case 2. At 100 years, with timber averaging more

than 2 feet in diameter, and a yield of 70,000 feet per acre, the cost is $11.46 per thousand for Case 1, and $10.74 per thousand for Case 2.

Table 6.—*Douglas fir in western Oregon and Washington.*

CASE 1.

Land and stocking, $10 per acre; administration and protection, 5 cents per acre; taxes, 10 cents per acre up to 40 years; thereafter 1 percent actual value, with reassessment every ten years; interest 4 percent.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.*	*Size, in.*	*Net Yield M. ft.*	*Cost per M.*	*Present stumpage price per M.*
40	$ 45.01	$ 4.75	$ 9.50	$ 59.26	10.6	24	$ 2.47	$1.00
50	68.07	7.63	17.30	93.00	13.7	35	2.66	1.25
60	102.20	11.90	31.21	145.31	16.2	43	3.38	1.50
70	152.72	18.21	54.29	225.32	18.4	50	4.50	1.75
80	227.50	27.56	91.22	346.28	20.5	57	6.08	2.00
90	338.19	41.40	149.06	528.65	22.5	64	8.26	2.25
100	502.05	61.88	238.26	802.19	24.3	70	11.46	2.50

CASE 2.

No annual tax on land or timber; final tax 25 percent of yield. Other factors as in Case 1.

Age Yrs.	*Land and stocking.*	*Administration and protection.*	*Taxes.*	*Total cost.**	*Size, in.*	*Net yield M. ft.†*	*Cost per M.*	*Present stumpage price per M.*
40	$ 45.01	$ 4.75	One	$ 49.76	10.6	18.0	$ 2.76	$1.00
50	68.07	7.63	quar-	75.70	13.7	26.3	2.88	1.25
60	102.20	11.90	ter	114.10	16.2	32.2	3.54	1.50
70	152.72	18.21	of	170.93	18.4	37.5	4.56	1.75
80	227.50	27.56	yield.	255.06	20.5	42.7	5.97	2.00
90	338.19	41.40		379.59	22.5	48.0	7.91	2.25
100	502.05	61.88		563.93	24.3	52.5	10.74	2.50

*Excluding taxes.
†Three-fourths of total yield, one-fourth deducted in lieu of taxes.

Because of the rapid growth and heavy yield, there is a possibility of getting more than 4 percent from a Douglas fir investment. At 5 percent, the cost of growing 50-year-old timber is $4.15 per thousand under Case 1, and $4.36 per thousand under Case 2. At 60 years, it is $5.70 per thousand for Case 1, and $5.86 per thousand for Case 2. With a 6 percent interest rate, the cost of production at 50 years is $6.49 per thousand for Case 1, and $6.70 per thousand for Case 2. At 60 years it is $9.67 and $9.88 per thousand, respectively.

All things considered, the outlook for Douglas fir is distinctly encouraging. The price of stumpage is certain to advance, and an increase of only two or three dollars per thousand will bring it to reproduction prices for ages up to 70 or 80 years. Such increases and far greater ones will likely take place before the timber can be grown. Cut-over Douglas fir land containing a sufficient quantity of young growth is evidently an excellent investment at $10 per acre. On the large areas of fir forests which are still intact, natural reproduction can be obtained at less than planting cost and profits increased accordingly.

PROPORTION OF DIFFERENT ELEMENTS IN TOTAL COST.

In order to see more clearly the influence of the various factors in the cost of growing timber, the percentage of the total cost contributed by

taxes, protection, and land and stocking, at ages of 50 and 90 years, under Cases 1 and 2, are given in Table 7.

Table 7.—*Proportion of total cost of growing timber caused by different factors under conditions specified in Tables 1 to 6.*

CASE 1.

	—FIFTY-YEAR OLD TIMBER—				—NINETY-YEAR OLD TIMBER—			
SPECIES—	*Taxes.*	*Administration and protection.*	*Land and stocking.*	*Total.*	*Taxes.*	*Administration and protection.*	*Land and stocking.*	*Total.*
	Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*	*Percent.*
White Pine	25.9	7.5	66.6	100	50.5	5.4	44.1	100
Loblolly Pine	29.6	7.1	63.3	100	...	..	...	...
Longleaf Pine	...	..	...	...	19.8	8.7	71.5	100
Red Oak	18.4	8.2	73.4	100	29.6	7.7	62.7	100
Yellow Poplar	18.6	8.2	73.2	100	31.3	7.5	61.2	100
Douglas Fir	18.6	8.2	73.2	100	28.2	7.8	64.0	100
CASE 2.								
All species	20.0	8.1	71.9	100	20.0	8.7	71.3	100

These percentages show unmistakably that with the exception of old white pine, taxed according to present methods, much the largest proportion of the total cost is due to land and stocking, as it should be. On the other hand, if present methods of taxation are strictly carried out, they take an increasingly larger share as the timber grows older. For 90-year white pine they amount to more than one-half the total cost, due to high stumpage prices, and for red oak, yellow poplar, and Douglas fir of the same age the taxes come to 28 to 31 percent of the total cost. The low percentage of taxes for longleaf pine at 90 years is because at that age it has not yet reached either a high yield or great value.

The statement for Case 2 emphasizes the point previously made that in some instances young growth is undertaxed by present methods, while by the same methods older timber is almost invariably overtaxed. It may easily happen, therefore, that while land and stocking usually constitute much the largest proportion of the cost of growing timber, the present system of taxing may be the determining factor in the decision as to whether or not forest conservation shall be practiced in a given region. With the tax on yield alone, the proportion of taxes to the total cost is the same in all ages.

The cost of administration and protection is low throughout. In no instance does it equal 9 percent of the total cost of growing the timber, and usually is less than 8 percent. Timber can be protected cheaply, and the cost of protection should not be a serious obstacle to forest conservation.

CONCLUSIONS.

The purpose of this paper is to outline a method of investigation into the cost of growing timber rather than to say definitely what the costs, yields, and stumpage prices will be for the various species in particular localities.

Certain general conclusions, however, can be drawn. It is evident that present stumpage prices of white pine are at a point where the growing of this timber should yield from 4 to 6 percent compound interest for a 40 to 70 year investment, with land and stocking costing not more than $10 per acre. The growing of loblolly pine should now offer a return of 4 percent compound interest for investments of from 30 to 50 years, with

land and stocking at $10 per acre. At the present rate of increase in stumpage values, red oak, yellow poplar, and Douglas fir will shortly bring remunerative prices. It is probable that cottonwood, red gum, southern white ash, and redwood have a rate of growth that will include them in the list of species which will soon reach stumpage prices covering the cost of growing. There is little room to doubt that with all these species the stumpage will reach a reproduction price long before the timber can be grown.

Present virgin timber is nearly always of greater age than can be grown with profit hereafter. This old timber usually has a larger percentage of the higher grades than "second-growth" or young timber. Hence, in value, virgin stumpage must be compared, not with the cost of the younger timber, but with that of the older classes. Under present methods of taxation, and to cover a 4 percent investment, virgin timber values should eventually rise to at least the cost of growing saw timber from 12 to 24 inches in diameter, say averaging 16 inches, except in cases where cheaper woods or other materials will furnish satisfactory substitutes.

This entire discussion has assumed an intelligent public conception of the value of forest property and the necessity for its protection from fire. Until such a sentiment crystallizes into efficient measures, rigidly enforced, many forest investments will continue to be hazardous. In some localities conditions are already such that forest investments on a moderate scale are reasonably safe.

Because of the long investments required, the cost of growing timber becomes unreasonable when high rates of interest are demanded. If private capital is unwilling to engage in it for an income of 4 to 5 percent, then the sooner a large proportion of the permanent timber land of the country comes into possession of the state or national governments, the more hopeful will be the outlook for future timber supplies. The chief concern of the state and national governments is the public welfare, and, moreover, they can profitably engage in operations at an even lower rate of interest than 4 percent.

APPENDIX.

COST TABLES.

To facilitate calculations of the cost of growing timber, the following tables, which show the charges for land and stocking, taxes and protection by decades from thirty to one hundred years, at various rates, have been prepared. The amounts for the several items are identical with those given for the corresponding items in Tables 1 to 6 of the text, except that in the latter tables the value of the bare land, assumed to be $3 per acre, is deducted from the totals, since the land remains an asset at the end of the operation. For strict calculations, therefore, the value of the land after cutting takes place should be deducted from the totals for land and stocking shown below:

LAND AND STOCKING.

	—ORIGINAL COST, $5 PER ACRE—				—ORIGINAL COST, $10 PER ACRE—			
	Amount at 3	*Amount at 4*	*Amount at 5*	*Amount at 6*	*Amount at 3*	*Amount at 4*	*Amount at 5*	*Amount at 6*
YEARS—	*percent.*	*percent.*	*percent.*	*percent.*	*percent.*	*percent.*	*percent.*	*percent.*
30.....	$12.14	$ 16.22	$ 21.61	$ 28.72	$ 24.27	$ 32.43	$ 43.22	$ 57.44
40.....	16.31	24.01	35.20	51.43	32.62	48.01	70.40	102.86
50.....	21.92	35.53	57.34	92.10	43.84	71.07	114.67	184.20
60.....	29.46	52.60	93.40	164.94	58.92	105.20	186.79	329.88
70.....	39.59	77.86	152.13	295.39	79.18	155.72	304.26	590.77
80.....	53.20	115.25	247.81	528.99	106.41	230.50	495.61	1,057.99
90.....	71.50	170.60	403.65	947.35	143.01	341.19	807.30	1,894.70
100.....	96.09	252.52	657.51	1,696.56	192.19	505.05	1,315.01	3,393.13

	—ORIGINAL COST, $15 PER ACRE—				—ORIGINAL COST, $20 PER ACRE—			
	Amount at 3	*Amount at 4*	*Amount at 5*	*Amount at 6*	*Amount at 3*	*Amount at 4*	*Amount at 5*	*Amount at 6*
YEARS—	*percent.*	*percent.*	*percent.*	*percent.*	*percent.*	*percent.*	*percent.*	*percent.*
30.....	$ 36.41	$ 48.65	$ 64.83	$ 86.15	$ 48.55	$ 64.87	$ 86.44	$ 114.87
40.....	48.93	72.02	105.60	154.29	65.24	96.02	140.80	205.71
50.....	65.76	106.60	172.01	276.30	87.68	142.13	229.35	368.40
60.....	88.37	157.79	280.19	494.82	117.83	210.39	373.58	659.77
70.....	118.77	233.57	456.40	886.16	158.36	311.43	608.53	1,181.54
80.....	159.61	345.75	743.42	1,586.98	212.82	461.00	991.23	2,115.97
90.....	214.51	511.79	1,210.96	2,842.05	286.01	682.39	1,614.61	3,789.40
100.....	288.28	757.57	1,972.52	5,089.69	384.37	1,010.10	2,630.02	6,786.25

TAXES.*

	——AMOUNT AT 3 PERCENT——				——AMOUNT AT 4 PERCENT——			
	Yearly cost per acre,	*Yearly cost per acre,*	*Yearly cost per acre,*	*Yearly cost per acre,*	*Yearly cost per acre,*	*Yearly cost per acre,*	*Yearly cost per acre,*	*Yearly cost per acre,*
YEARS—	*10 cents.*	*15 cents.*	*20 cents.*	*25 cents.*	*10 cents.*	*15 cents.*	*20 cents.*	*25 cents.*
30.....	$ 4.76	$ 7.14	$ 9.52	$ 11.89	$ 5.61	$ 8.41	$ 11.22	$ 14.02
40.....	7.54	11.31	15.08	18.85	9.50	14.25	19.01	23.76
50.....	11.28	16.92	22.56	28.20	15.27	22.90	30.53	38.17
60.....	16.31	24.46	32.61	40.76	23.80	35.70	47.60	59.50
70.....	23.06	34.59	46.12	57.65	36.43	54.64	72.86	91.07
80.....	32.14	48.20	64.27	80.34	55.12	82.69	110.25	137.81
90.....	44.33	66.50	88.67	110.84	82.80	124.20	165.60	207.00
100.....	60.73	91.09	121.46	151.82	123.76	185.64	247.52	309.41

* If it is desired to compute the taxes at some rate not given above, the amount may be obtained by using either the figures given in the table for protection or by combining them with those in this table. For example, the total tax at a rate of 19 cents for sixty years at 3 percent is equivalent to the total tax at 4 cents ($6.52 in the protection table) plus the total tax at 15 cents ($24.46 in the tax table), or $30.98.

Years—	Amount at 5 percent: Yearly cost per acre, 10 cents.	Yearly cost per acre, 15 cents.	Yearly cost per acre, 20 cents.	Yearly cost per acre, 25 cents.	Amount at 6 percent: Yearly cost per acre, 10 cents.	Yearly cost per acre, 15 cents.	Yearly cost per acre, 20 cents.	Yearly cost per acre, 25 cents.
30	$ 6.64	$ 9.97	$ 13.29	$ 16.61	$ 7.91	$ 11.86	$ 15.81	$ 19.76
40	12.08	18.12	24.16	30.20	15.48	23.21	30.95	38.69
50	20.93	31.40	41.87	52.34	29.03	43.55	58.07	72.58
60	35.36	53.04	70.72	88.40	53.31	79.97	106.63	133.28
70	58.85	88.28	117.71	147.13	96.80	145.19	193.59	241.99
80	97.12	145.68	194.25	242.81	174.66	262.00	349.33	436.66
90	159.46	239.19	318.92	398.65	314.12	471.17	628.23	785.29
100	261.00	391.50	522.01	652.51	563.85	845.78	1,127.71	1,409.64

ADMINISTRATION AND PROTECTION.

Yrs.	Amount at 3 percent: Yearly cost per acre, 1 cent.	Yearly cost per acre, 2 cents.	Yearly cost per acre, 3 cents.	Yearly cost per acre, 4 cents.	Yearly cost per acre, 5 cents.	Yearly cost per acre, 6 cents.	Amount at 4 percent: Yearly cost per acre, 1 cent.	Yearly cost per acre, 2 cents.	Yearly cost per acre, 3 cents.	Yearly cost per acre, 4 cents.	Yearly cost per acre, 5 cents.	Yearly cost per acre, 6 cents.
30	$0.48	$0.95	$1.43	$1.90	$2.38	$2.85	$0.56	$1.12	$1.68	$2.24	$2.80	$3.37
40	.75	1.51	2.26	3.02	3.77	4.52	.95	1.90	2.85	3.80	4.75	5.70
50	1.13	2.26	3.38	4.51	5.64	6.77	1.53	3.05	4.58	6.11	7.63	9.16
60	1.63	3.26	4.89	6.52	8.15	9.78	2.38	4.76	7.14	9.52	11.90	14.28
70	2.31	4.61	6.92	9.22	11.53	13.84	3.64	7.29	10.93	14.57	18.21	21.86
80	3.21	6.43	9.64	12.85	16.07	19.28	5.51	11.02	16.54	22.05	27.56	33.07
90	4.43	8.87	13.30	17.73	22.17	26.60	8.28	16.56	24.84	33.12	41.40	49.68
100	6.07	12.15	18.22	24.29	30.36	36.44	12.38	24.75	37.13	49.50	61.88	74.26

Yrs.	Amount at 5 percent: Yearly cost per acre, 1 cent.	Yearly cost per acre, 2 cents.	Yearly cost per acre, 3 cents.	Yearly cost per acre, 4 cents.	Yearly cost per acre, 5 cents.	Yearly cost per acre, 6 cents.	Amount at 6 percent: Yearly cost per acre, 1 cent.	Yearly cost per acre, 2 cents.	Yearly cost per acre, 3 cents.	Yearly cost per acre, 4 cents.	Yearly cost per acre, 5 cents.	Yearly cost per acre, 6 cents.
30	$0.66	$1.33	$1.99	$2.66	$3.32	$3.99	$0.79	$1.58	$2.37	$3.16	$3.95	$4.74
40	1.21	2.42	3.62	4.83	6.04	7.25	1.55	3.10	4.64	6.19	7.74	9.29
50	2.09	4.19	6.28	8.37	10.47	12.56	2.90	5.81	8.71	11.61	14.52	17.42
60	3.54	7.07	10.61	14.14	17.68	21.22	5.33	10.66	15.99	21.33	26.66	31.99
70	5.89	11.77	17.66	23.54	29.43	35.31	9.68	19.36	29.04	38.72	48.40	58.08
80	9.71	19.42	29.14	38.85	48.56	58.27	17.47	34.93	52.40	69.87	87.33	104.80
90	15.95	31.89	47.84	63.78	79.73	95.68	31.41	62.82	94.23	125.65	157.06	188.47
100	26.10	52.20	78.30	104.40	130.50	156.60	56.39	112.77	169.16	225.54	281.93	338.31